

# **A Summary of ACPI Climate Downscaling Studies for the Western United States**

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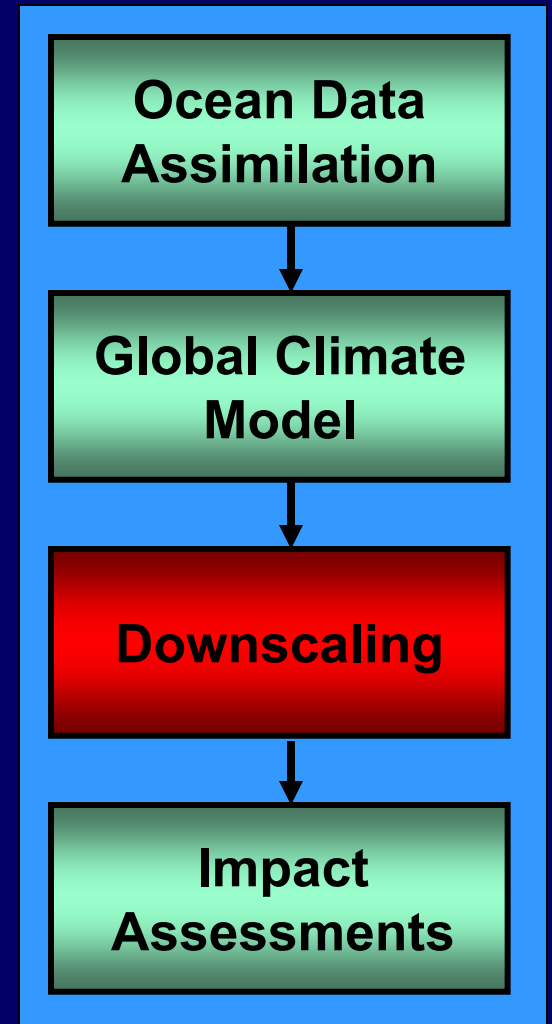
Scripps Institute of Oceanography, San Diego, CA

2001 AGU Fall Meeting

December 10-14, 2001, San Francisco, CA

# Objectives

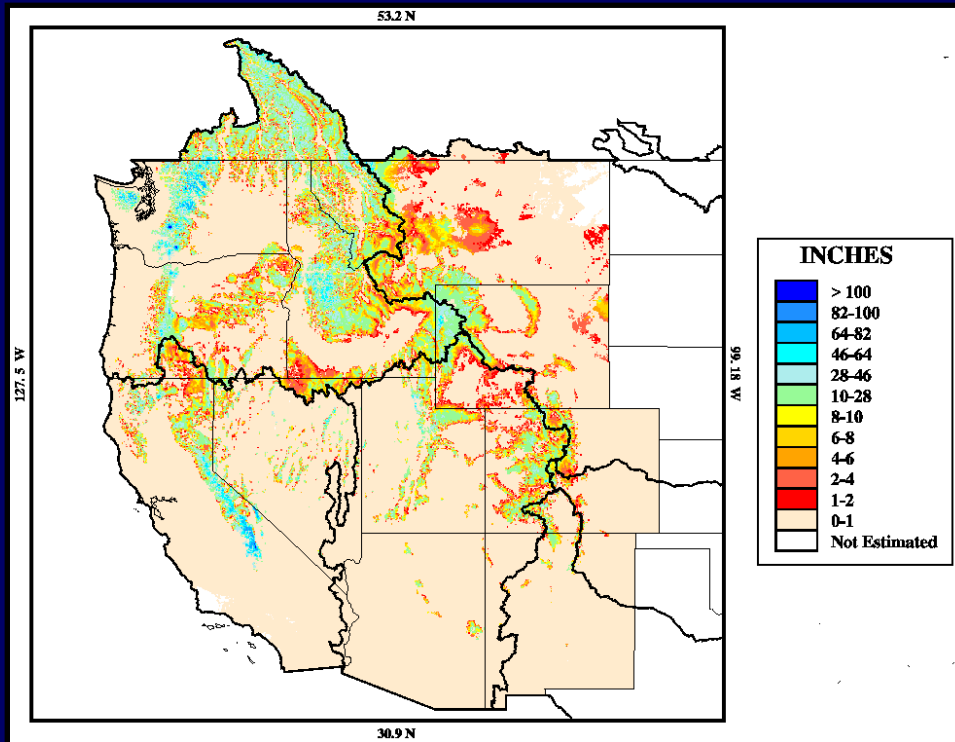
- To evaluate downscaling methods for the western U.S.
- To intercompare dynamical and statistical downscaling methods
- To provide downscaled climate scenarios for climate impacts assessment



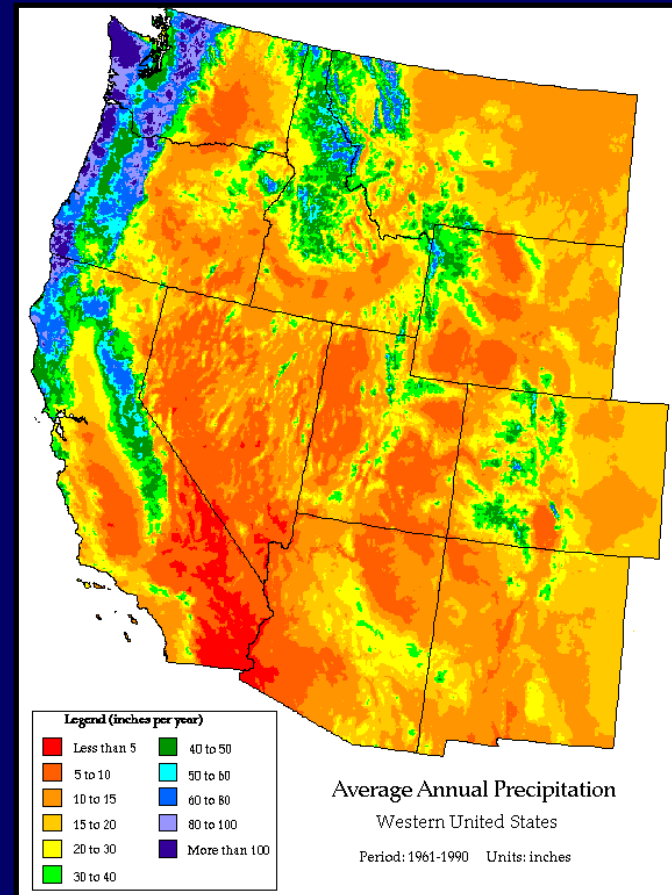
# Climate of Western U.S. is Strongly Affected by Terrain:

Model capability to resolve terrain features is critical

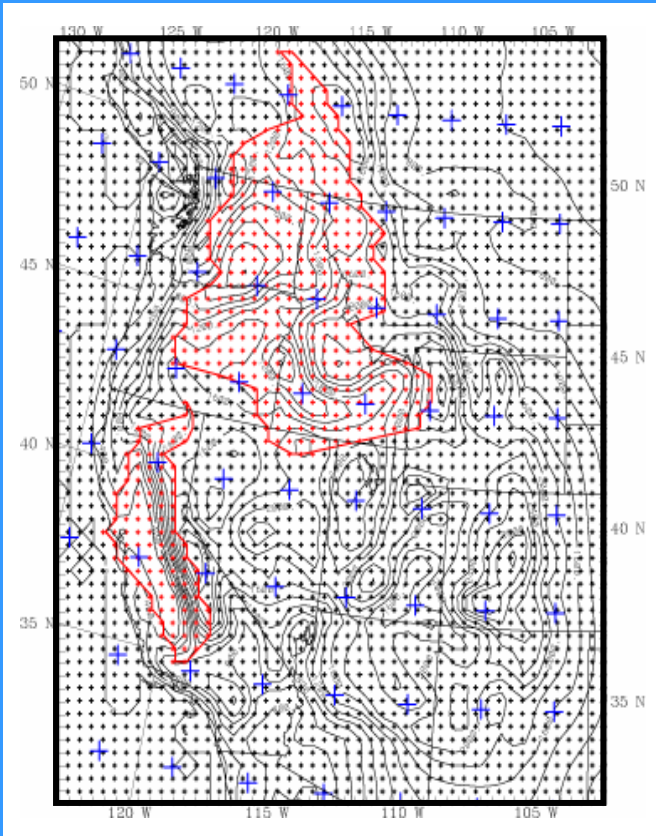
Observed snow pack in March, 1998



Observed mean annual precipitation



# ACPI Downscaling Results



- Two regional models (MM5, RSM) have been evaluated when driven by realistic large scale conditions from the NCEP/NCAR and ECMWF reanalyses.
- Intercomparison of regional simulations have been performed at the Columbia River and Sacramento-San Joaquin basins.
- Both MM5 and RSM are being used to downscale the PCM control and future climate conditions.
- Regional simulations have been provided to impact assessment team.

# Data Archives

- **PCM outputs:**

6-Hourly (5.5 GB); Daily (0.4 GB); Monthly (0.3 GB) – total 2.2 TB for 350 years and selected hourly data

- **MM5 outputs:**

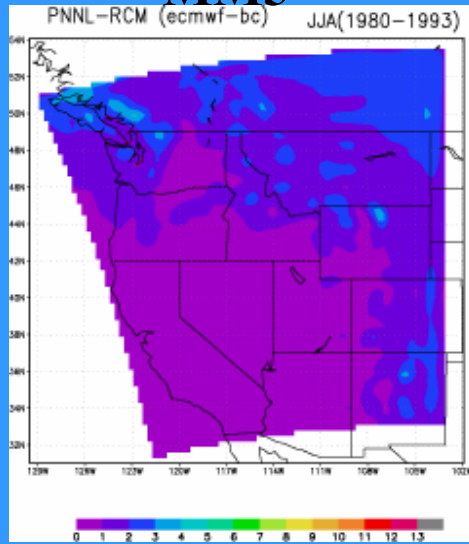
Daily (0.2 GB), 3-Hourly (0.8 GB), 6-Hourly (6.4 GB) – total 0.8 TB for 110 years

- **RSM outputs:**

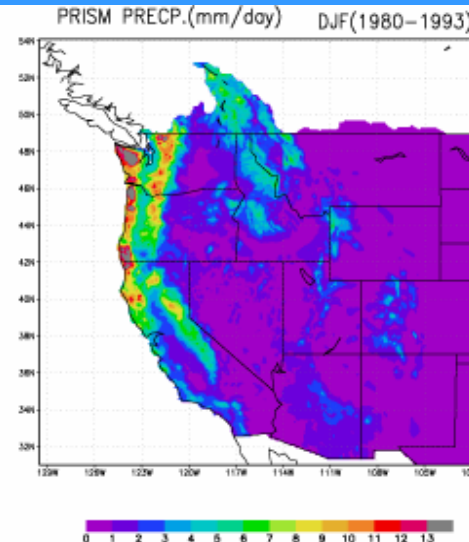
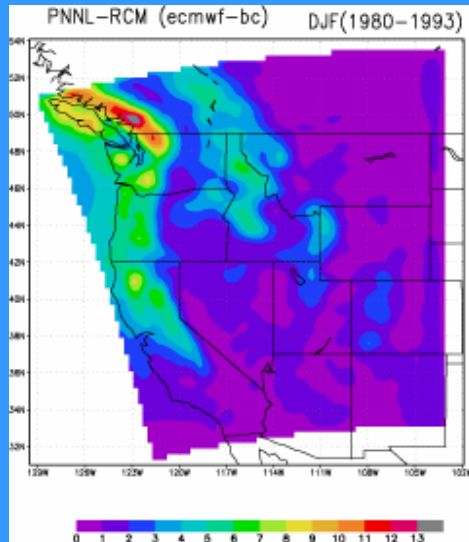
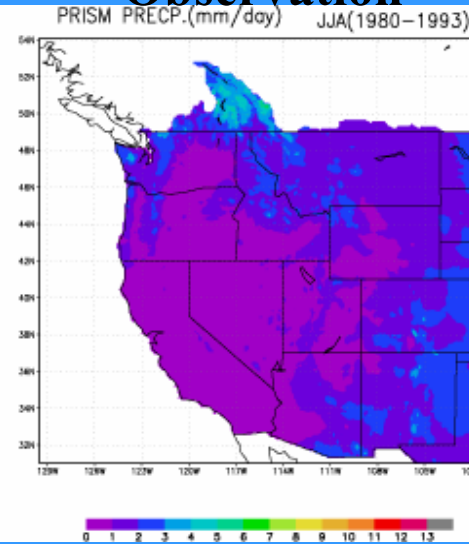
3-Hourly (1.0 GB) – total of 75 GB for 75 years

# Seasonal Precipitation: Simulation Driven by ECMWF Reanalyses

**MM5**

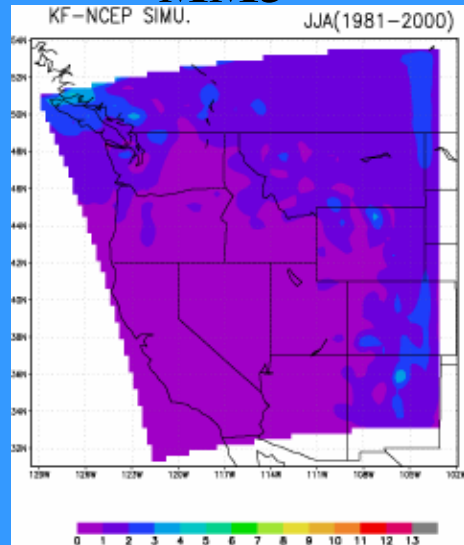


**Observation**

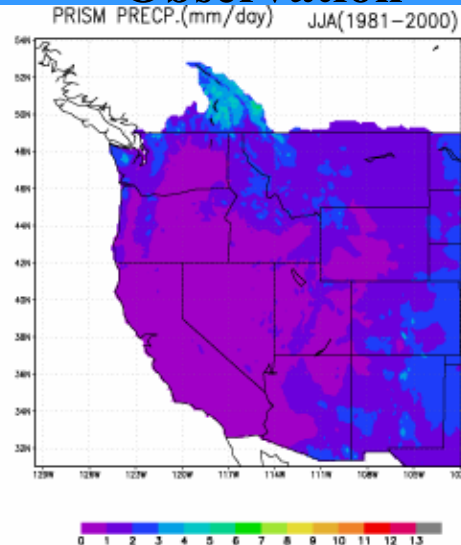


# Seasonal Precipitation: Simulation Driven by NCEP/NCAR Reanalyses

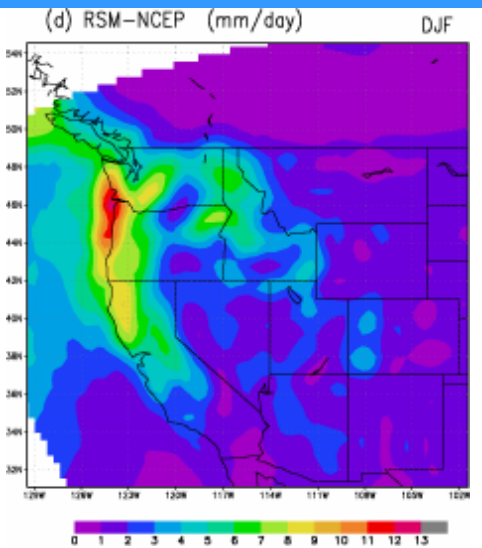
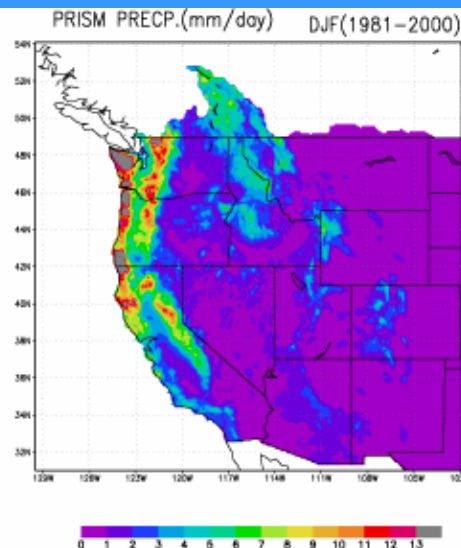
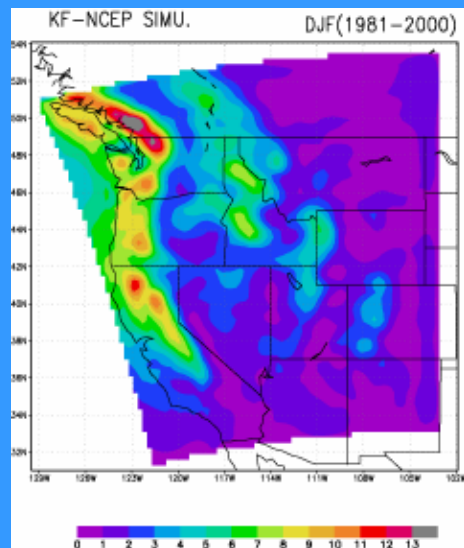
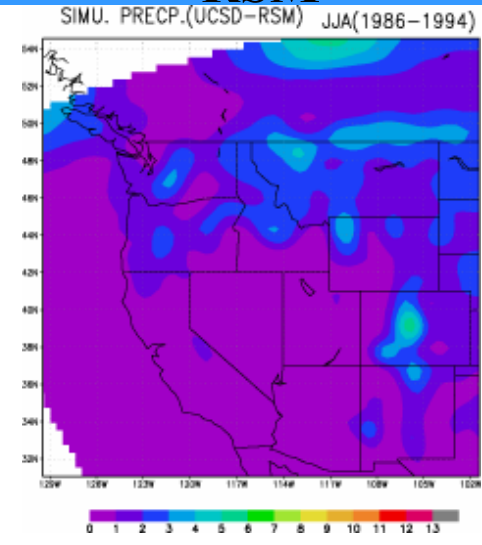
**MM5**



**Observation**



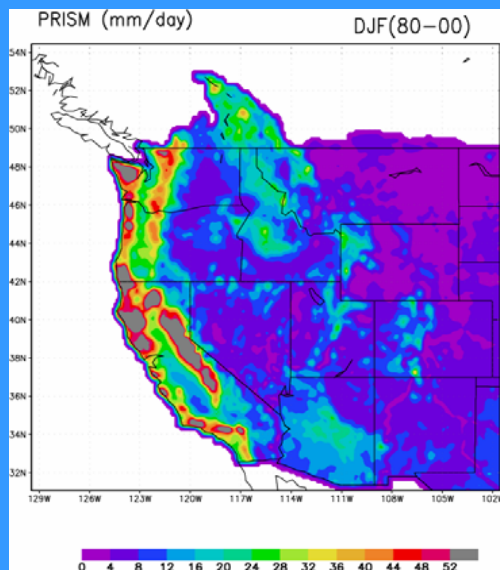
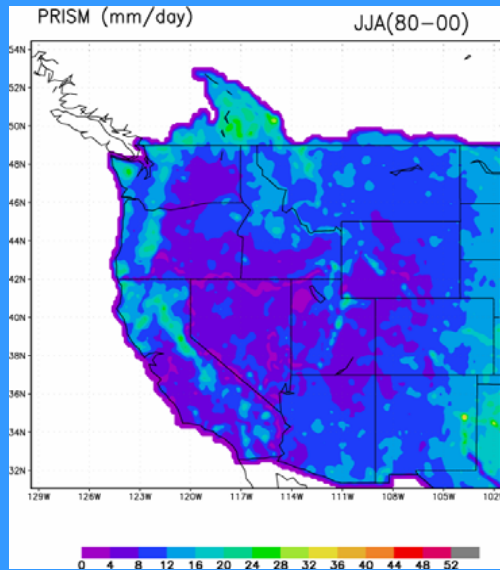
**RSM**



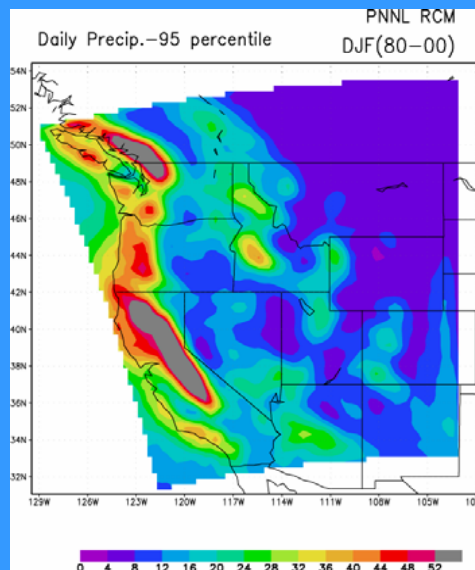
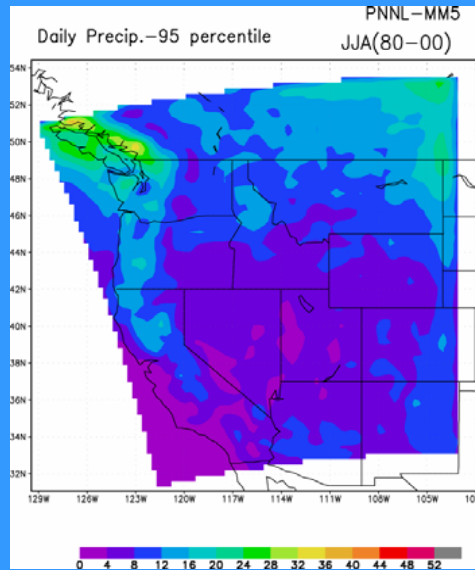


# Comparison of Extreme Precipitation

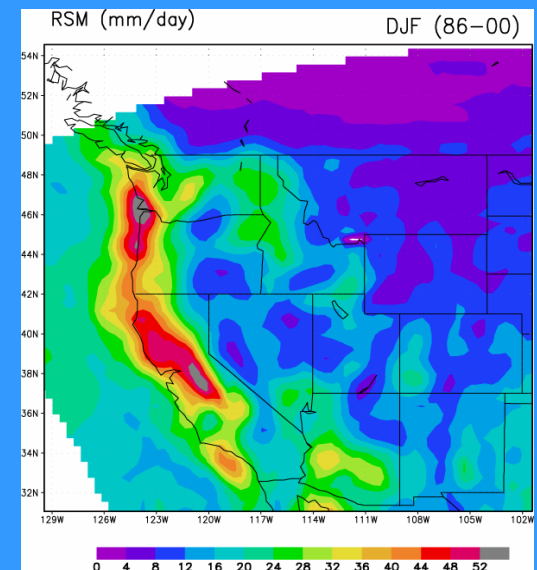
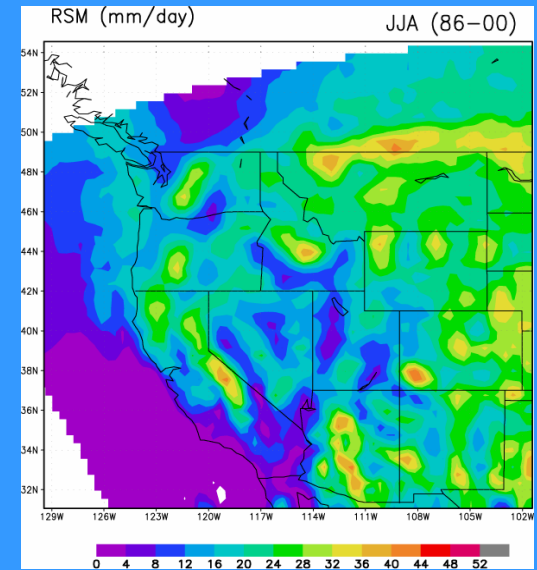
## Observation



## MM5

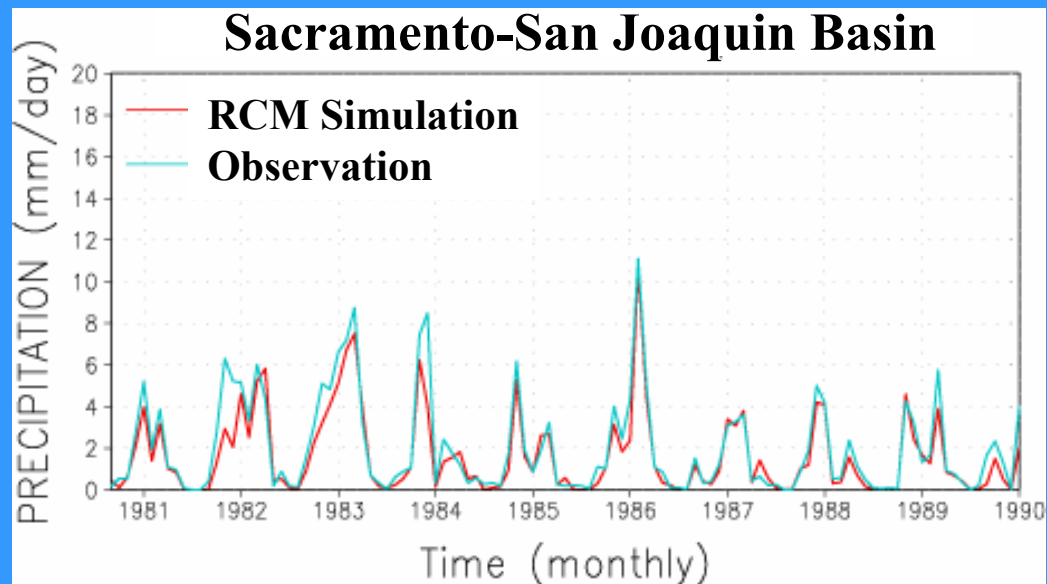
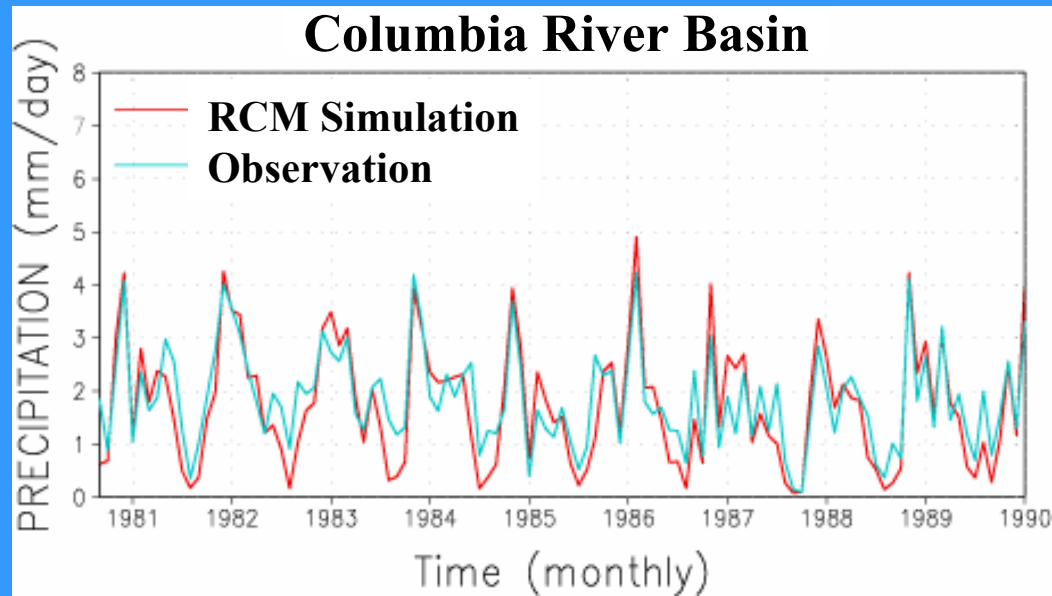


## RSM

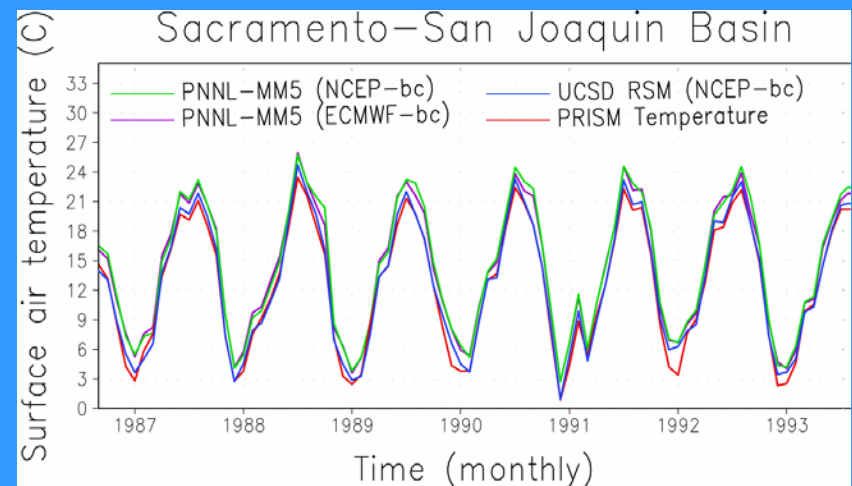
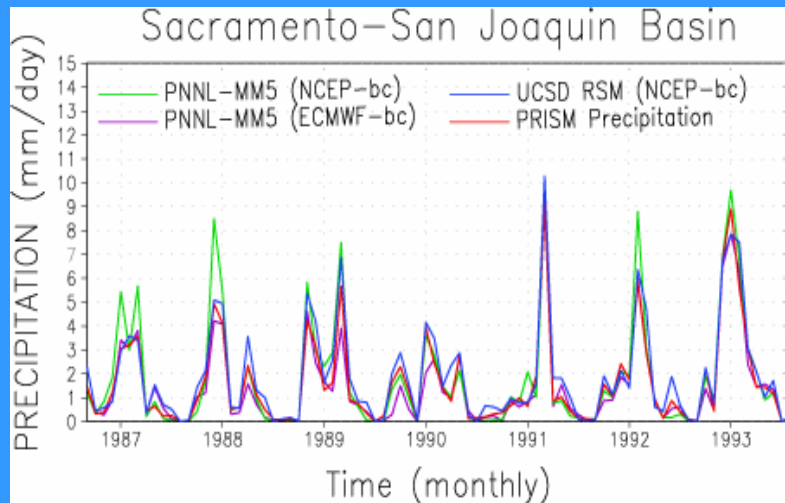
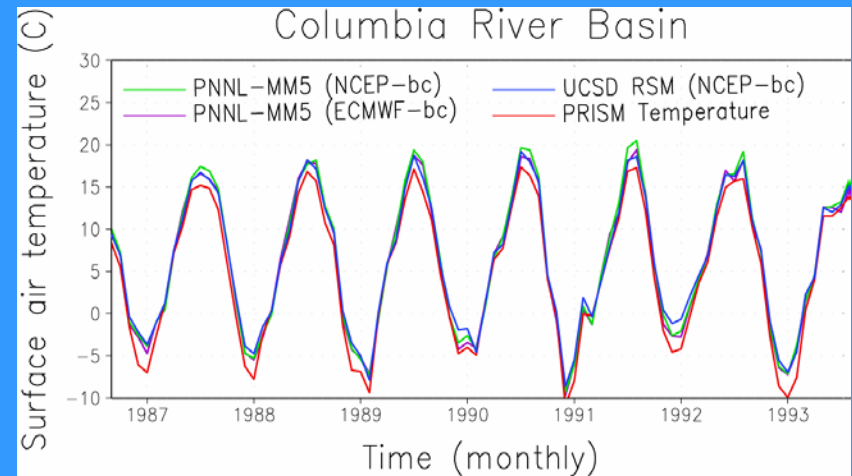
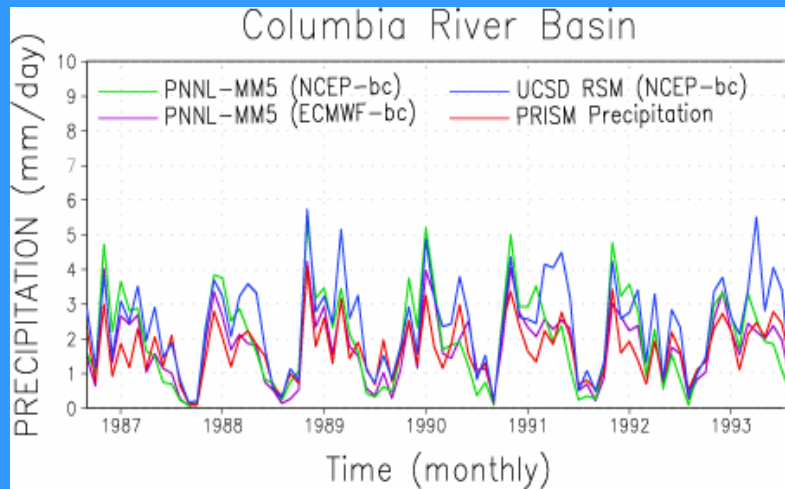




# Basin Mean Monthly Precipitation

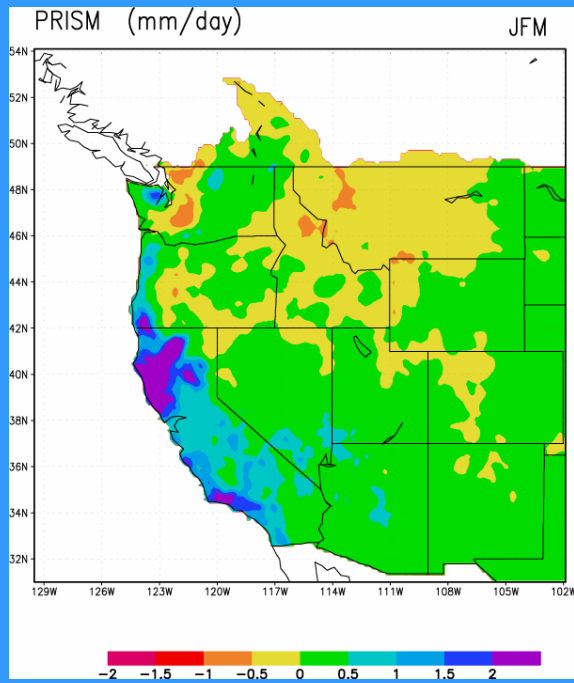


# Comparison of Simulations

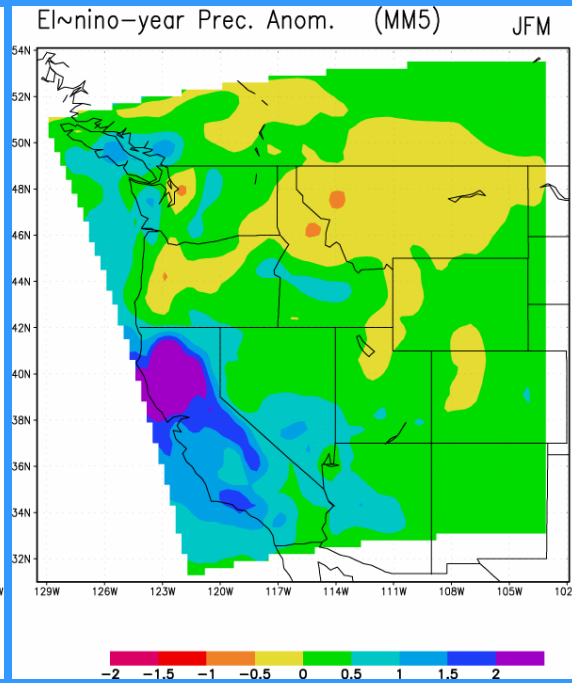


# Observed and Simulated El Nino Precipitation Anomaly

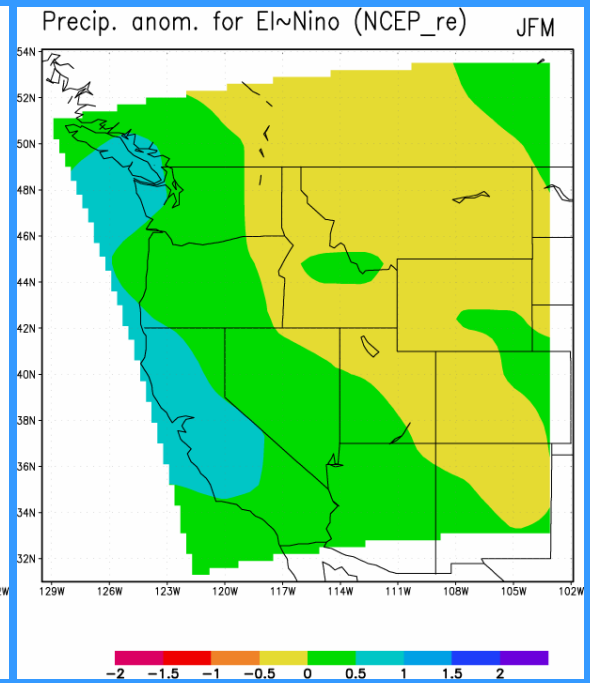
## Observation



## RCM Simulation



## NCEP Reanalyses

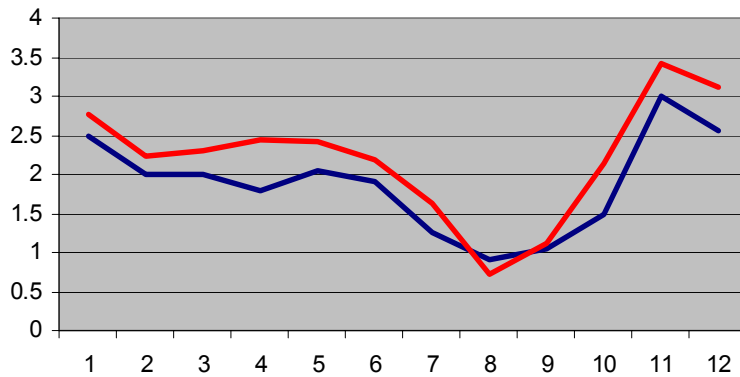


# PCM Simulated Realistic Seasonal Cycle of Precipitation and Temperature

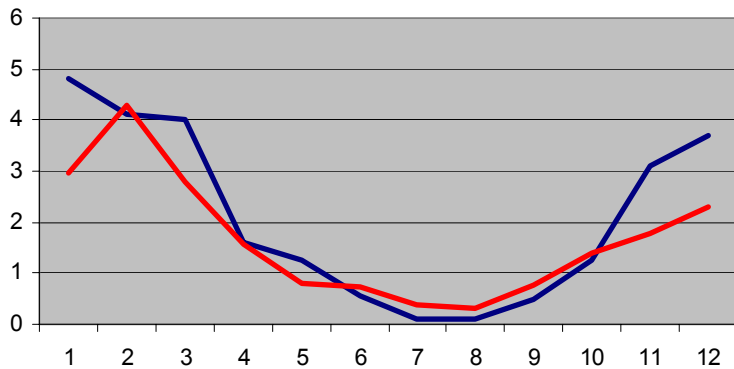
— Observation  
— PCM simulation

Precipitation (mm/day)

## Columbia River Basin

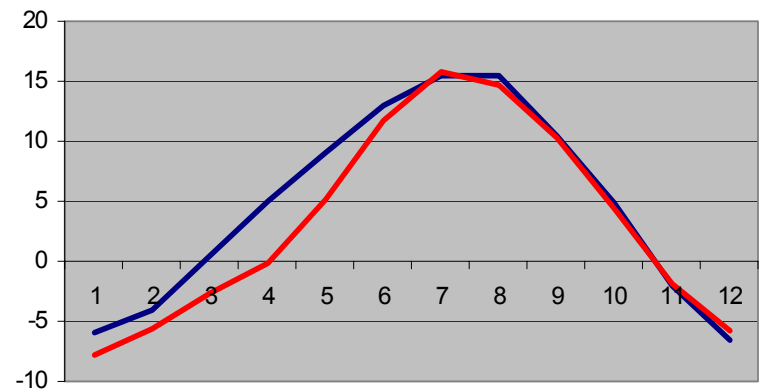


## Sacramento-San Joaquin Basin



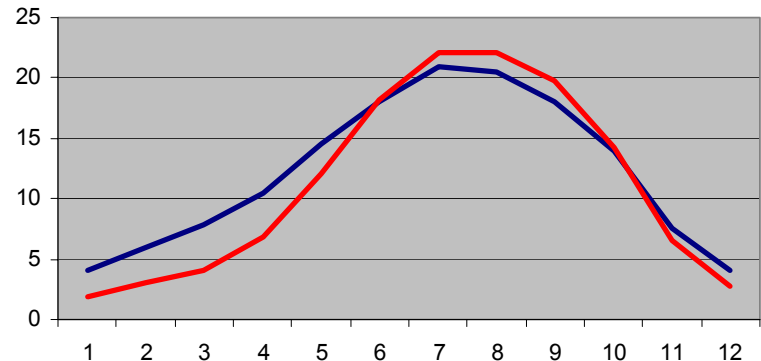
Month

## Columbia River Basin



Surface Temperature (C)

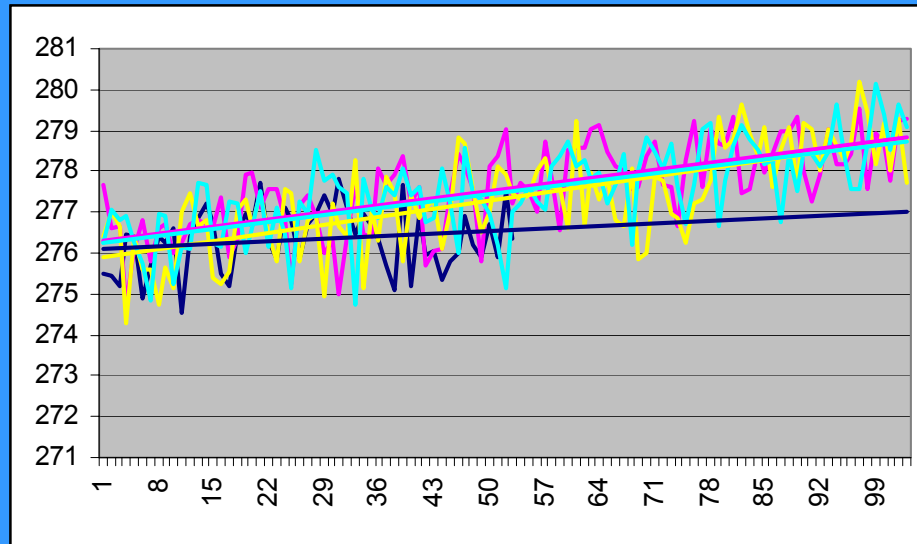
## Sacramento-San Joaquin Basin



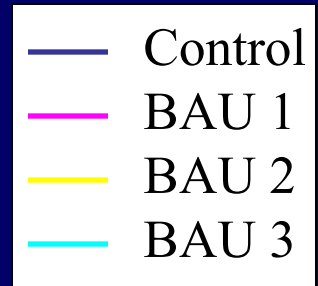
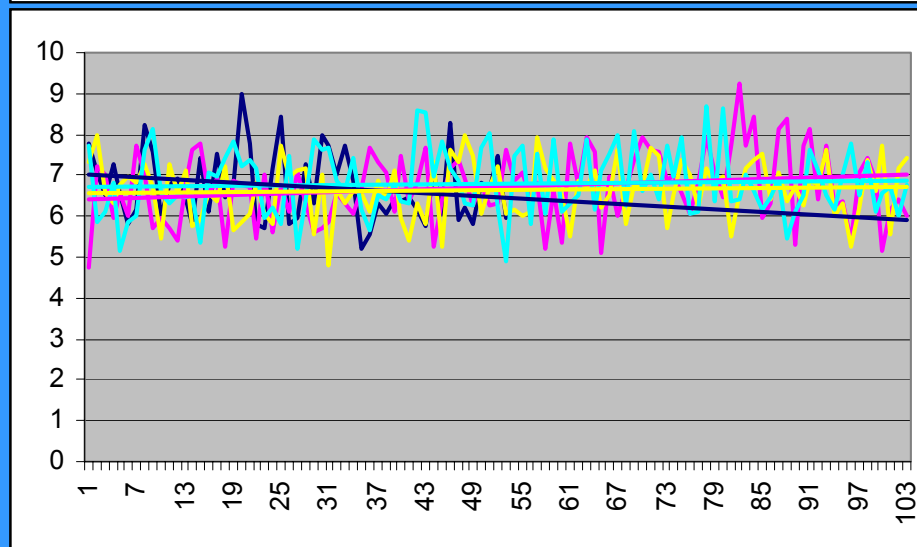
Month

# PCM Annual Temperature and Precipitation at the Columbia River Basin

Temperature (K)



Precipitation (mm/day)



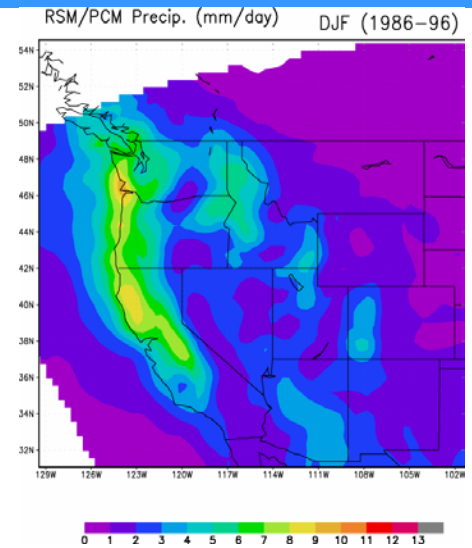
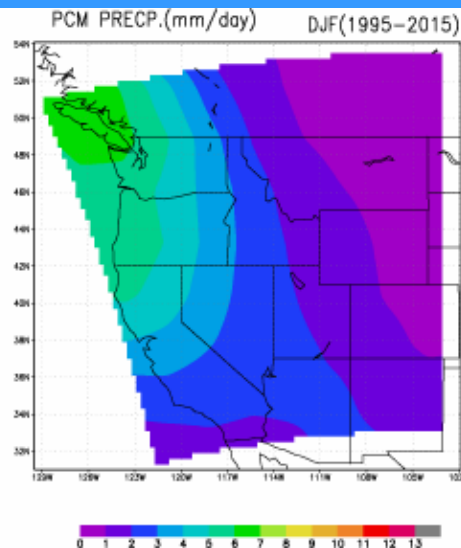
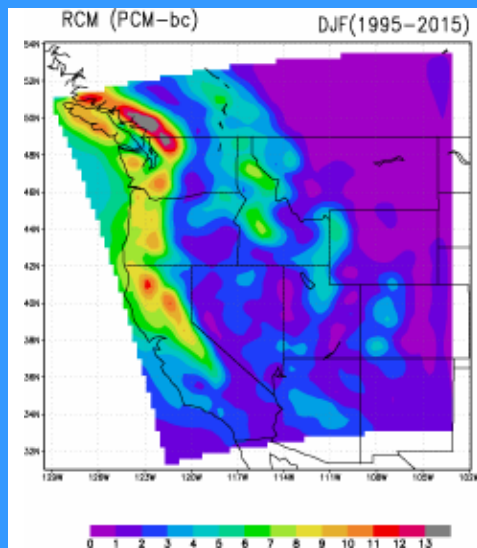
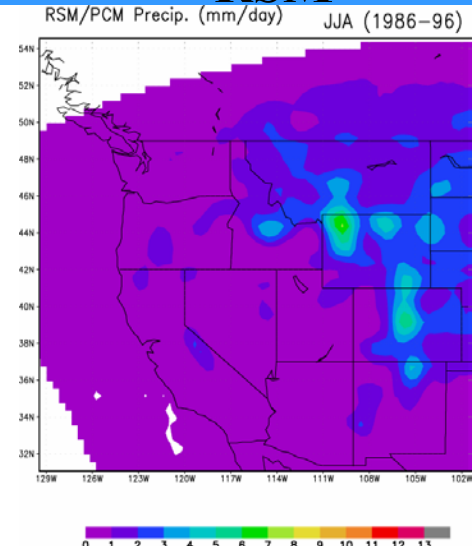
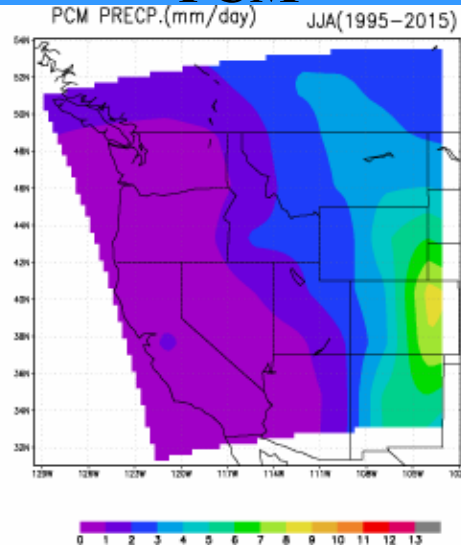
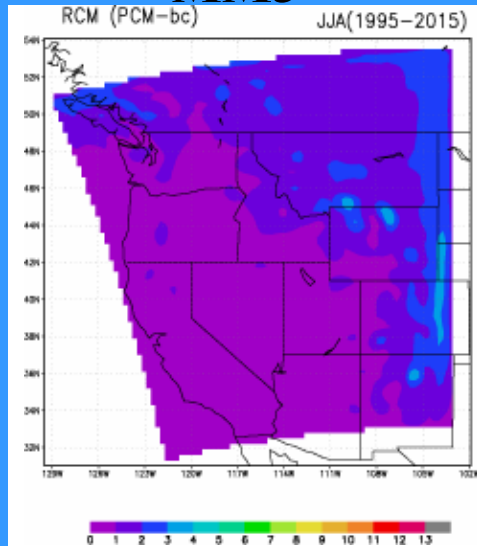
Years

# Seasonal Precipitation: PCM and RCM Control Simulations

**MM5**

**PCM**

**RSM**





# Ensemble Mean PCM Temperature Signal

## B06.44 JJA 2040-2050

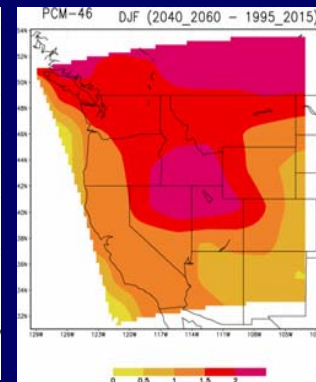
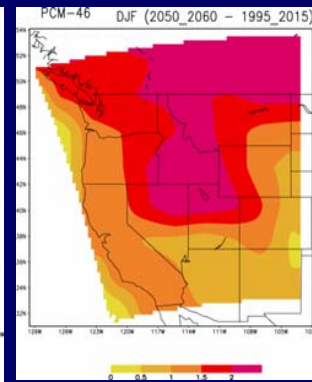
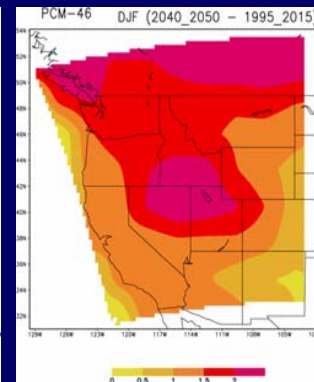
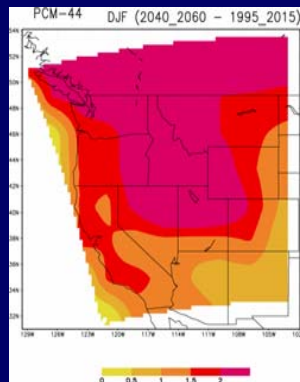
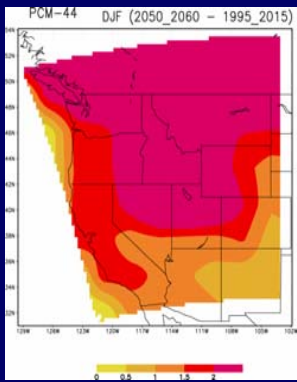
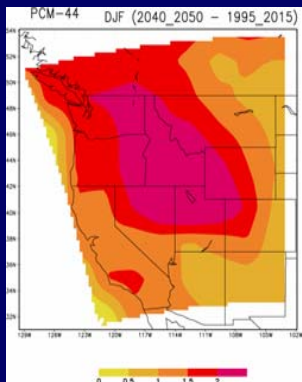
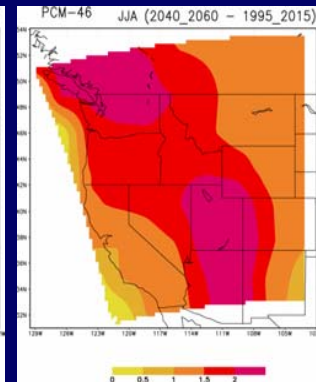
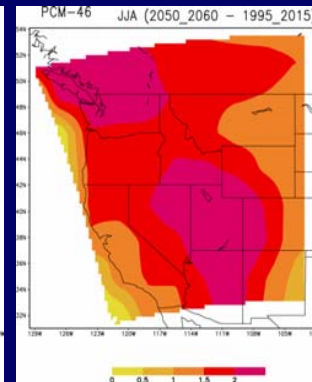
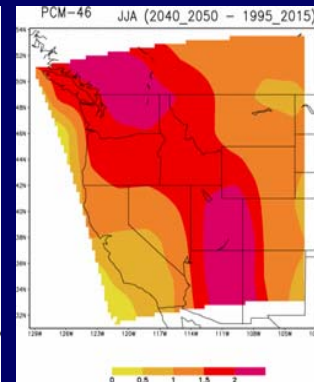
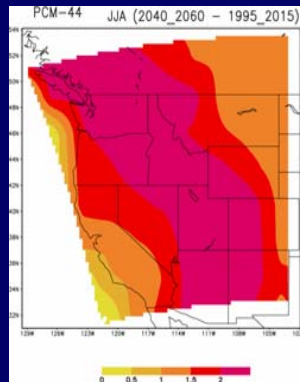
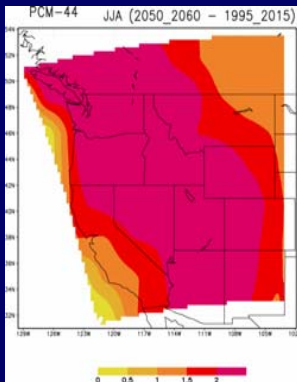
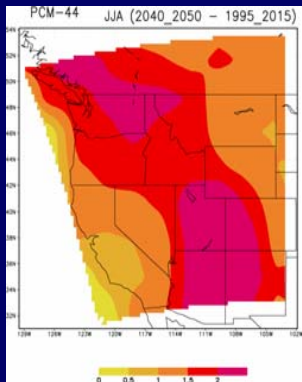
**B06.44 JJA**  
**2050-2060**

# B06.44 JJA 2040-2060

**B06.46 JJA**  
**2040-2050**

# B06.46 JJA 2050-2060

# B06.46 JJA 2040-2060



## B06.44 DJF 2040-2050

**B06.44 DJF  
2050-2060**

## B06.44 DJF 2040-2060

## B06.46 DJF 2040-2050

# B06.46 DJF 2050-2060

# B06.46 DJF 2040-2060

# Ensemble Mean PCM Precipitation Signal

## B06.44 JJA 2040-2050

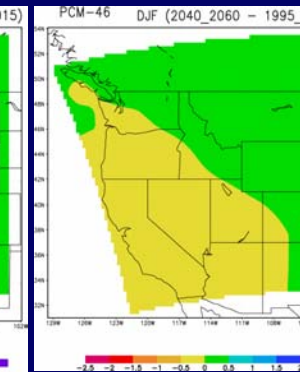
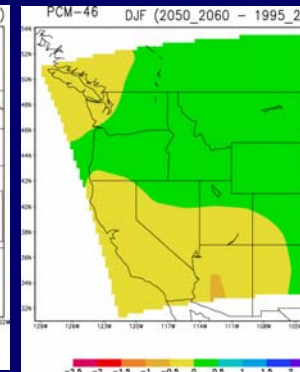
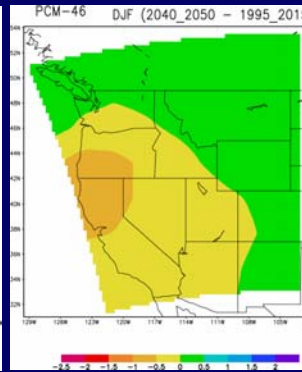
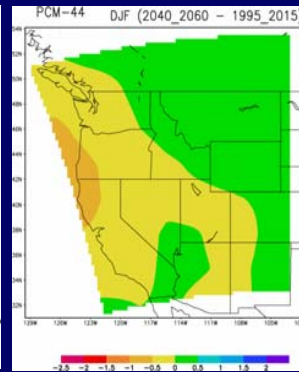
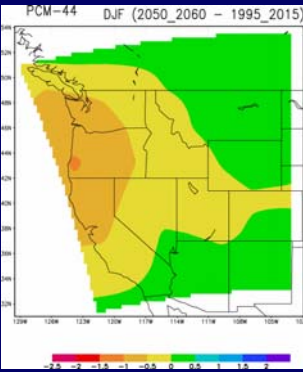
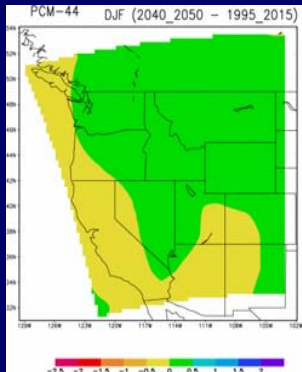
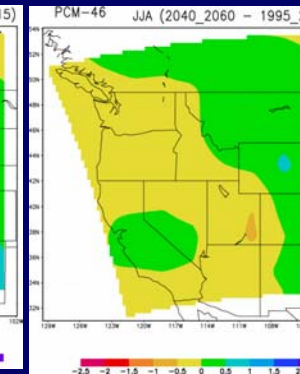
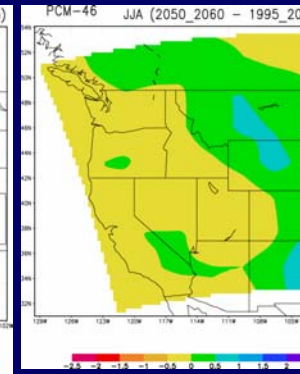
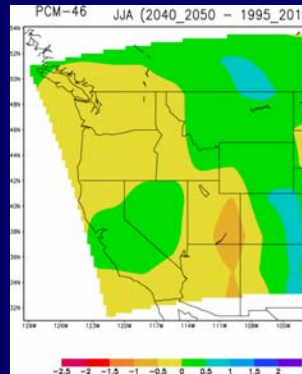
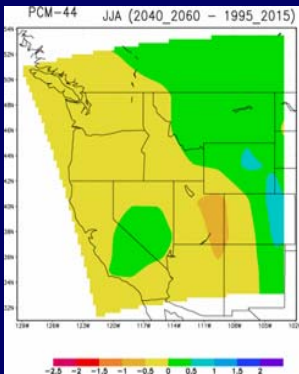
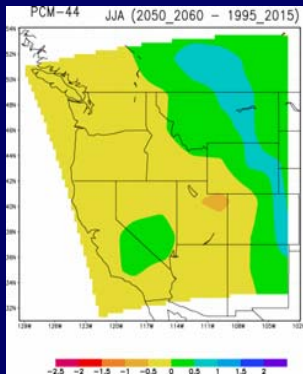
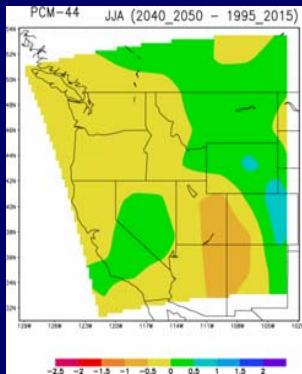
**B06.44 JJA**  
**2050-2060**

# B06.44 JJA 2040-2060

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## B06.44 DJF 2040-2050

**B06.44 DJF**  
**2050-2060**

## B06.44 DJF 2040-2060

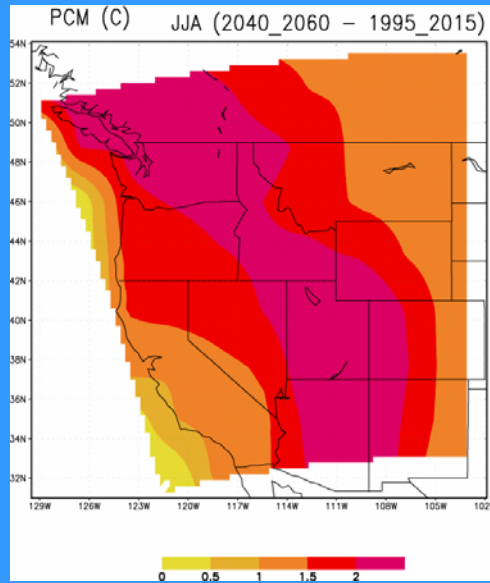
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**B06.46 DJF**  
**2050-2060**

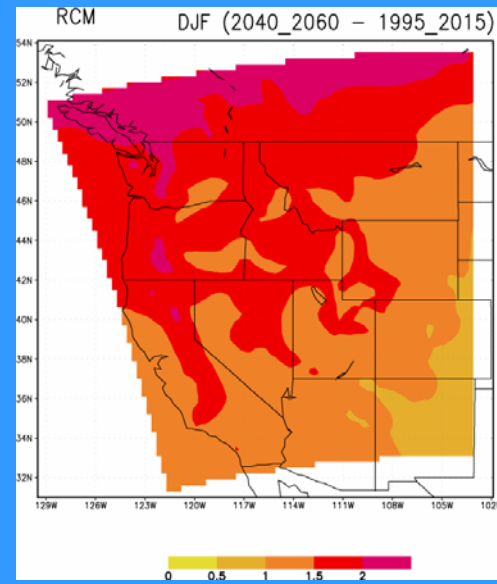
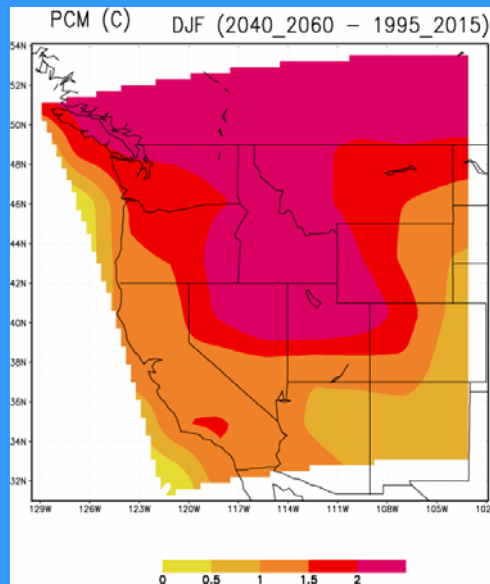
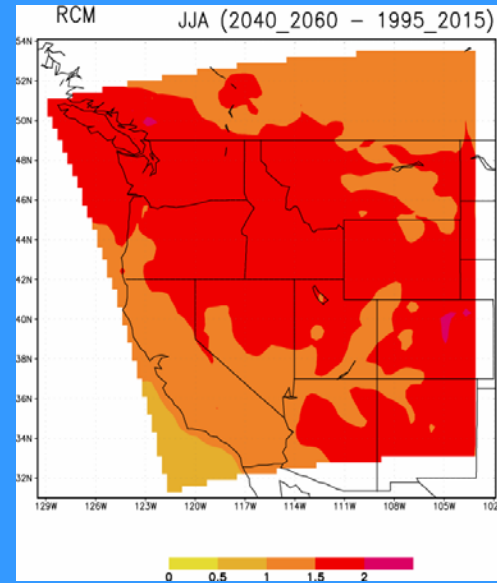
# B06.46 DJF 2040-2060

# Seasonal Temperature: climate Signal

**PCM**

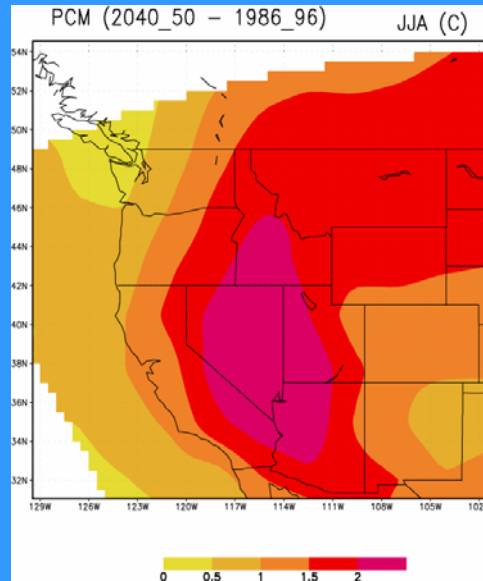


**MM5**

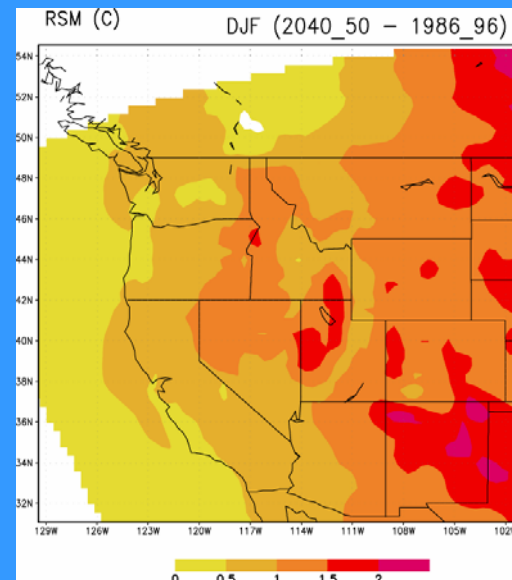
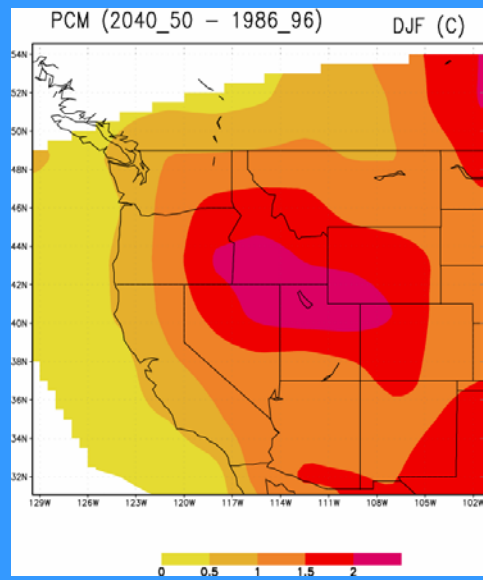
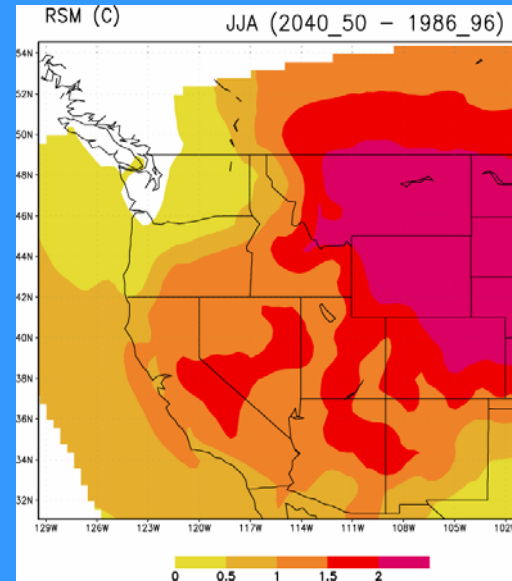


# Seasonal Temperature: climate Signal

**PCM**



**RSM**



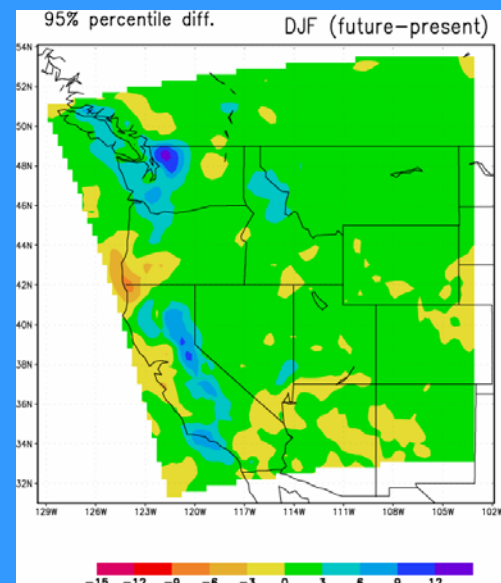
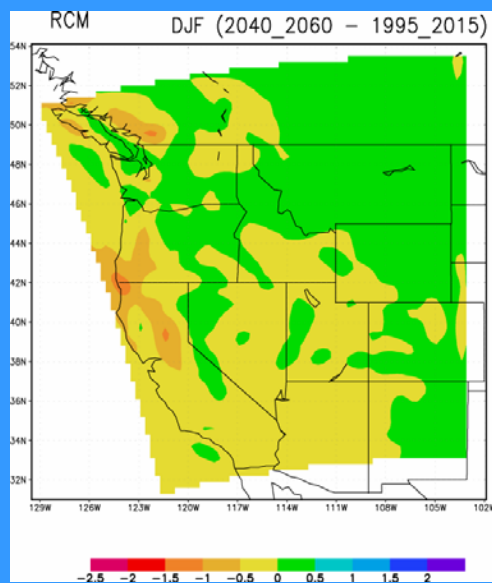
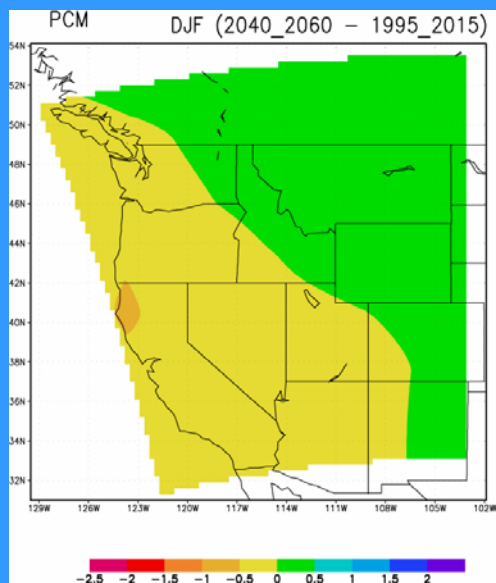
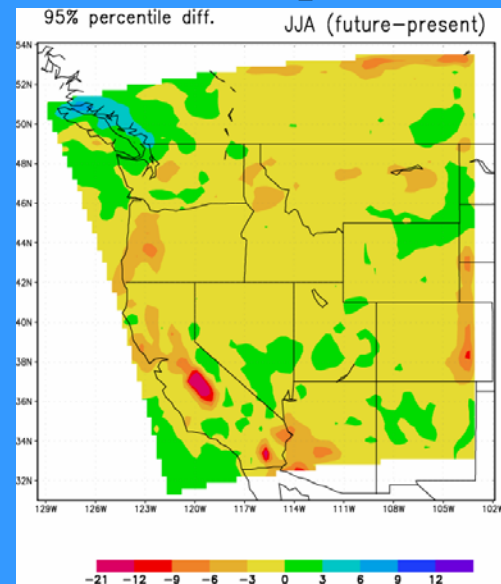
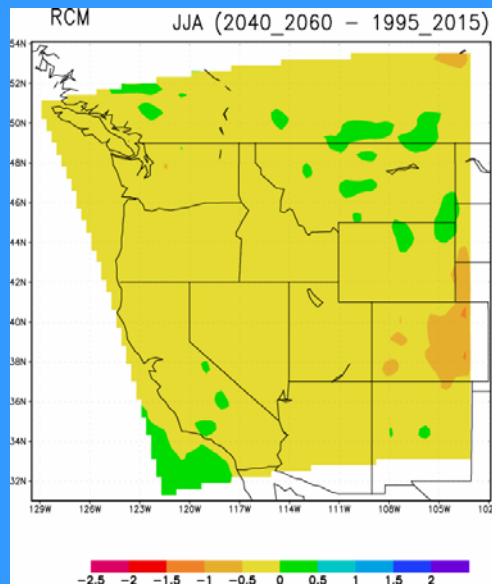
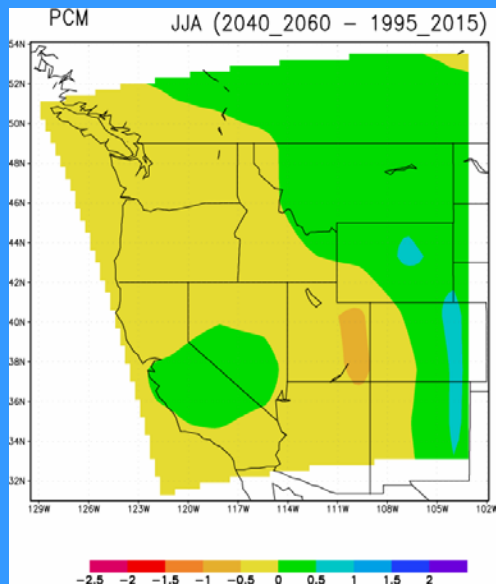


# Seasonal Precipitation: Climate Signal

PCM

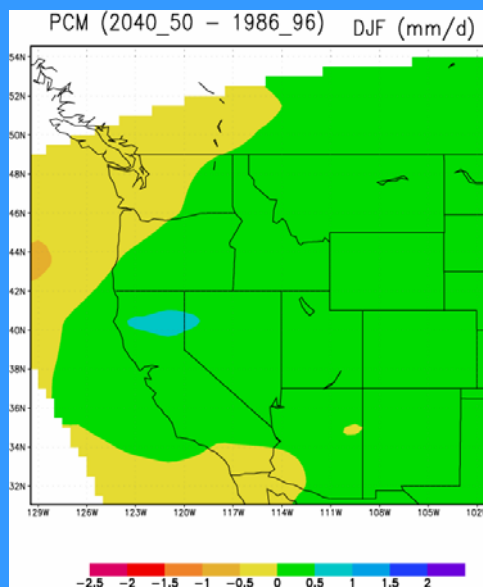
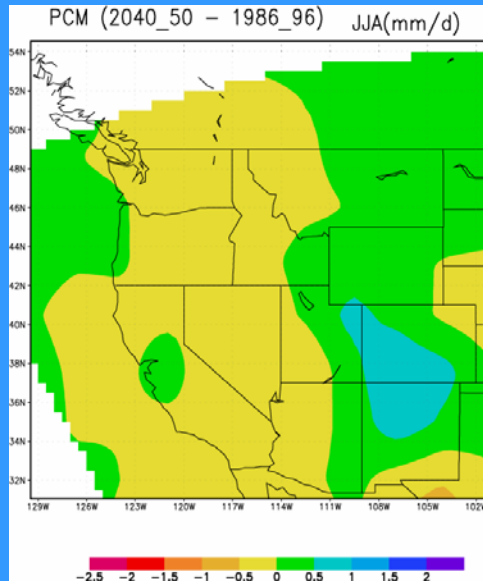
MM5

MM5 – 95<sup>th</sup> percentile

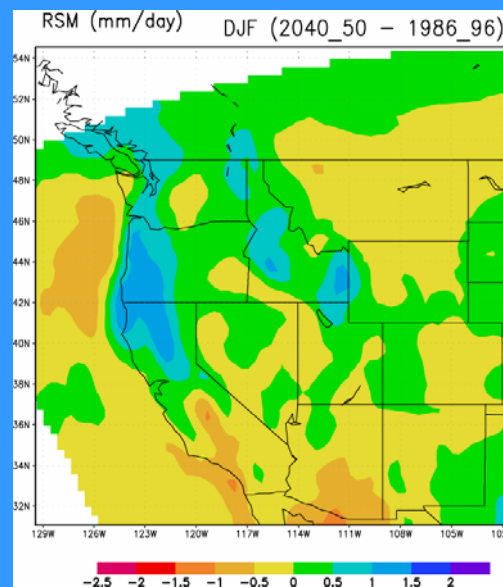
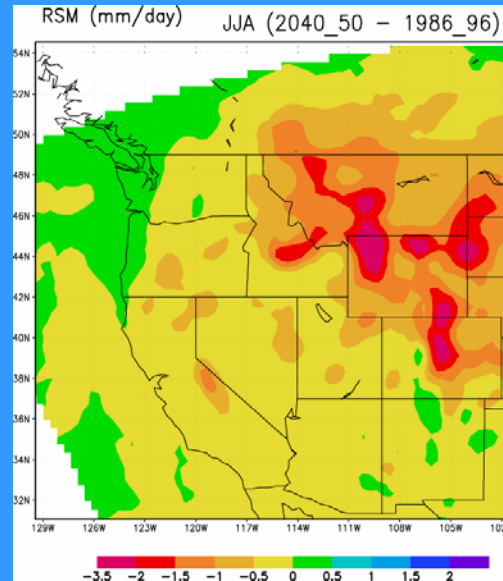


# Seasonal Precipitation: Climate Signal

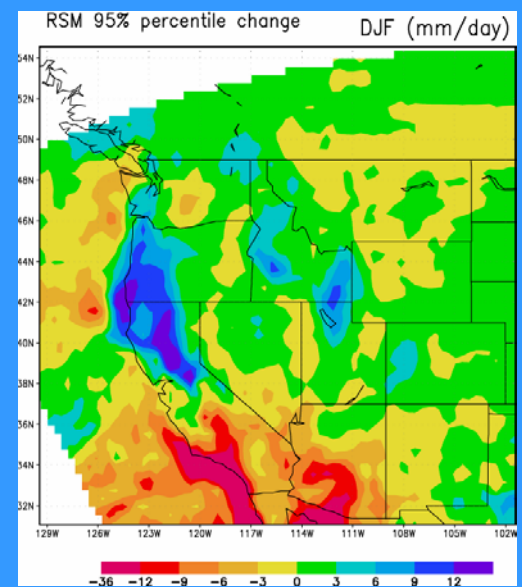
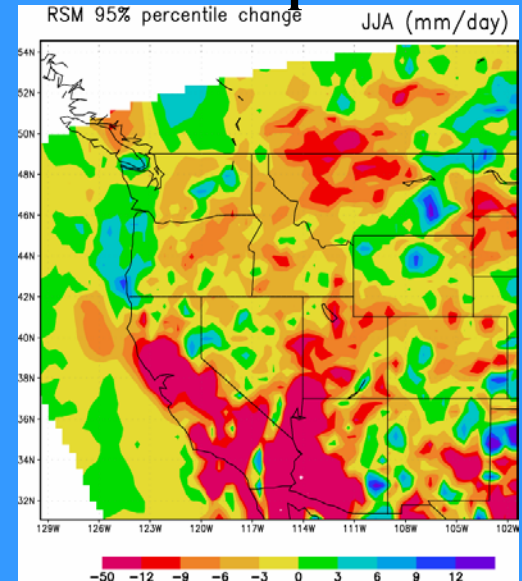
## PCM



## RSM

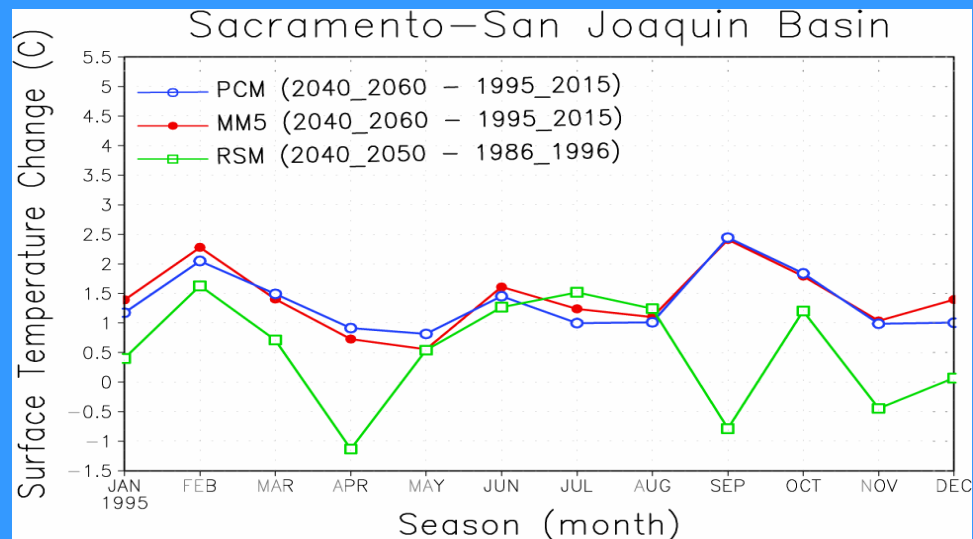
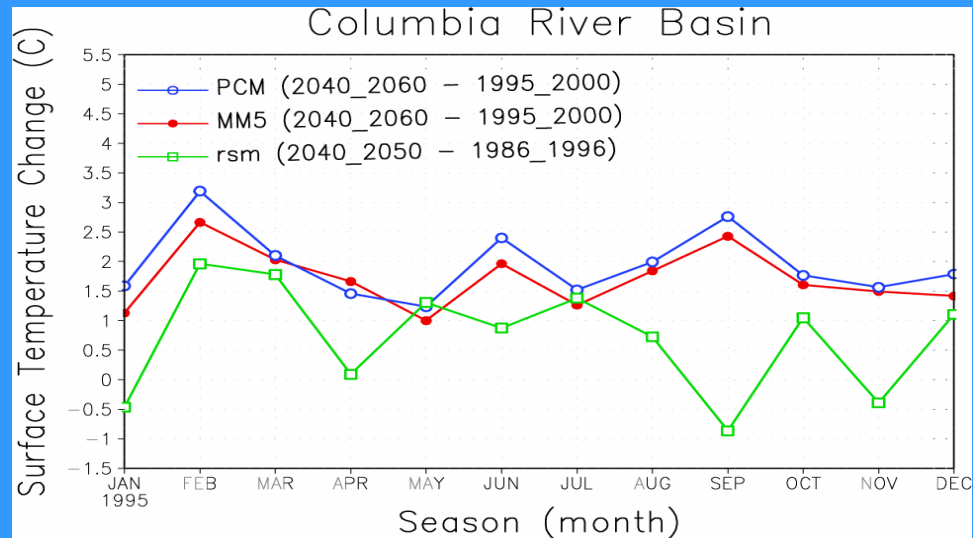


## RSM 95<sup>th</sup> percentile

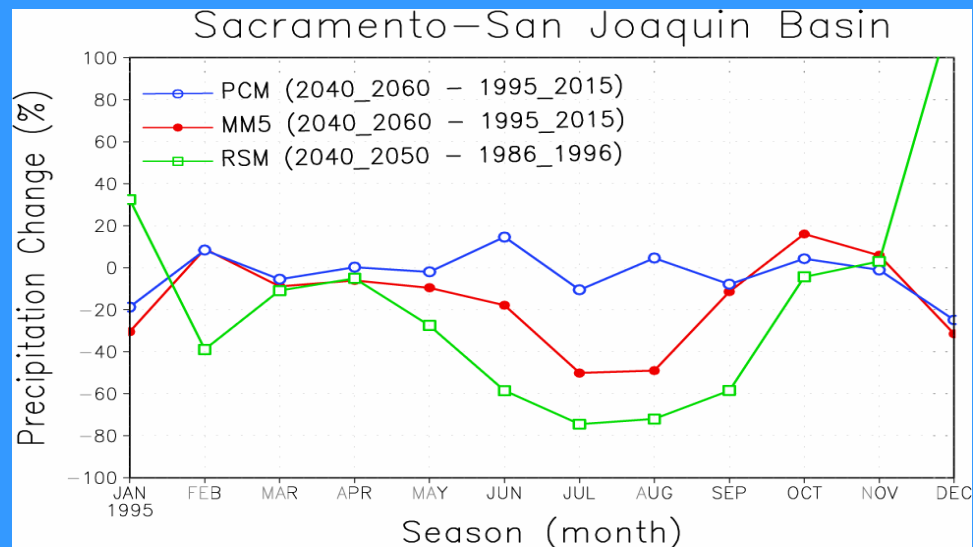
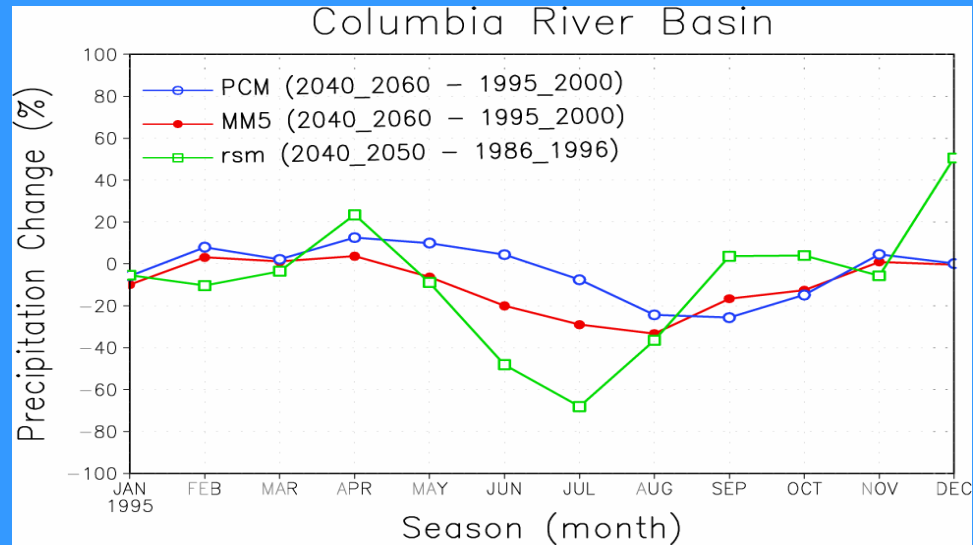




# Monthly Temperature: Climate Signal Simulated by PCM and RCM



# Seasonal Precipitation: Climate Signal Simulated by PCM and RCM



# Conclusions

- Differences exist between MM5 and RSM simulations for both summer and winter seasons.
- Interannual variability is realistically simulated by both models at the river basins when driven by reanalyses.
- PCM control simulation reproduces seasonal cycle of temperature and precipitation at the river basins.
- Ensemble means over 20 years are more similar to each other than 10-year averages.
- Downscaling accentuates temperature and precipitation (especially extreme) changes over mountainous regions.